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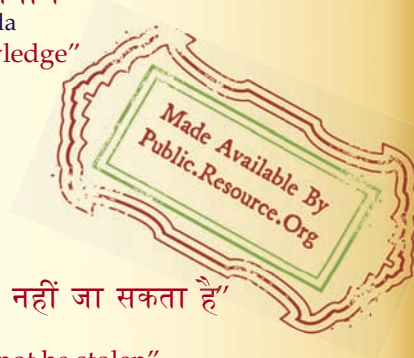
IS 8791 (1978): Code of practice for ultrasonic flaw detection of ferritic steel forgings [MTD 21: Non-Destructive Testing]



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Indian Standard
CODE OF PRACTICE FOR
ULTRASONIC FLAW DETECTION OF
FERRITIC STEEL FORGINGS

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Indian Standard

CODE OF PRACTICE FOR ULTRASONIC FLAW DETECTION OF FERRITIC STEEL FORGINGS

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Indian Standard
**CODE OF PRACTICE FOR
ULTRASONIC FLAW DETECTION OF
FERRITIC STEEL FORGINGS**

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 10 April 1978, after the draft finalized by the Non-Destructive Testing Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 When applying ultrasonic techniques, it is essential that the operators be fully conversant with the characteristics of the equipment to be used and have fair knowledge of the method of manufacture of the forging under test, and the type, position and probable distribution of the defects likely to be present. It is emphasized that diagnosis of the nature of defects located by ultrasonic flaw detection may only be made by consideration of both metallurgical and ultrasonic factors.

0.3 For the purpose of quality assessment, the forgings are classified into three categories according to the size of flaw indication, in this standard. When specified in the contract, the flaw size may also be expressed as the percentage of the amplitude distance corrected back wall echo.

NOTE — The echo from a large reflector (back echo) is reduced slightly with increasing distance in the near-field and then decreases rapidly in the far field. In the far field, the amplitude of large reflectors is inversely proportional to the distance, so that if the distance is doubled, the amplitude is halved. But, the amplitude of small reflectors follow inverse square law, so that if the distance is doubled, the amplitude will be reduced by a factor of 4. Hence one should be careful while specifying the flaw size as a percentage of back echo.

0.4 It is preferable to perform the ultrasonic examination of forgings after heat treatment for mechanical properties but prior to drilling holes, cutting keyways, machining sections to contour. If such machining of heat-treated parts is difficult from the production point of view, forgings may be tested before heat treatment. Further, in such cases, the forging should be tested as completely as possible after heat treatment also.

0.5 While preparing this standard, assistance has been drawn from BS 4124: Part I: 1967 Methods for non-destructive testing of steel forgings, Part I Ultrasonic flaw detection, issued by the British Standards Institution.

0.6 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard deals with the ultrasonic testing of ferritic steel forgings. The procedures cover pulse echo direct contact manual ultrasonic flaw detection technique. This standard does not apply to austenitic steel forgings.

2. TERMINOLOGY

2.1 For the purpose of this standard, the terms and definitions given in IS : 2417-1977† shall apply.

3. EQUIPMENT CHARACTERISTICS

3.1 Frequency Range — The ultrasonic equipment shall be suitable for operating at frequencies within the range of 0.5 to 6.0 MHz.

3.2 Sensitivity — The sensitivity of the equipment shall be tested to ensure that the number of full screen back wall echo is not less than that given below, when the appropriate probe is placed on the metallized surface of plastic insert of the reference block for calibration conforming to IS : 4904-1972‡:

<i>Frequency Range</i> MHz	<i>Minimum Number of</i> <i>Full Screen Back Echo</i>
1 to 1.5	5
1.5 to 2	4
2.0 to 2.5	3
2.5 to 6	2

3.3 Resolution — The resolution of the equipment and probe combined shall be such as to show separately indications from two or more nearby reflecting surfaces when the difference in beam path lengths between them does not exceed twice the wavelength.

*Rules for rounding off numerical values (*revised*).

†Glossary of terms relating to ultrasonic testing (*first revision*).

‡Specification for reference blocks for calibration of ultrasonic flow detection (*first revision*).

3.4 Linearity of Time Base — The time base shall, as far as practicable, be linear, and for critical examination any deviation shall not exceed one percent over the full width of the screen.

3.5 Linearity of Amplification — In the absence of suppression, the amplifier shall be linear within ± 2 dB to at least half full-screen height and any deviation above this should be known to the operator. 'Suppression' (or 'reject'), whether built-in or applied by switching, affects linearity of amplification and the effect of suppression over the full range shall be recorded if this is to be used.

4. SURFACE CONDITION

4.1 The surface of the forging shall be free from loose scales, rust and such other extraneous materials that would interfere with the ultrasonic energy transmission. The adhered scales formed during forging need not be removed if this does not interfere with the test. In the case of machined surface, it is desirable to have a surface finish of 6.25 microns or better.

5. COUPLANT

5.1 To ensure adequate transmission of ultrasonic energy between the probe and the forging, a suitable couplant having good wetting characteristics, such as oil, grease, water, glycerine (with a wetting agent) or cellulose paste shall be used.

5.1.1 Same couplant should be used for both calibration and testing purposes.

6. TESTING TECHNIQUE

6.1 Selection of testing technique shall be made after giving due consideration to the method of manufacture and shape of forging. Testing technique should be such that each and every part of the forging volume is scanned at least once. To ensure complete coverage of the volume, the search unit shall be indexed with 15 to 25 percent overlap with each pass. The techniques mentioned in **6.2** to **6.5** are considered to be minimum for providing adequate coverage.

6.2 Solid and Hollow Cylindrical Forgings — The complete length of forging shall be scanned radially from the circumferential surface through 360° using normal beam probes. Wherever practicable, the forging shall be scanned in axial direction also. When specified, forging shall also be scanned using appropriate shear wave probes.

6.3 Solid Rectangular Forging — The complete length of the forging shall be scanned from two adjacent faces using normal beam probe. Whenever

practicable, the forging shall be scanned in axial direction also. When specified the forging shall be scanned using shear wave probe to detect defects which are oriented at an angle to the axis.

6.3.1 Hollow Rectangular Forgings — The forgings shall be tested all over (that is, through all six faces over their complete surface) using a normal beam probe.

NOTE — For both cylindrical and rectangular forgings, it is often desirable to examine, while still in the solid state, forgings which are to be bored.

6.4 Multi-Sided Forging — The forging shall be scanned in the same way as specified for cylindrical forgings.

6.5 Complex Forging — The complete volume of forging shall be scanned using normal beam and, whenever practicable, appropriate shear wave probes.

NOTE — When a forging is manufactured by upsetting as a final operation, then all surfaces of the forging shall be examined using normal beam probe.

7. SCANNING

7.1 Probes and Frequency — For overall scanning 2—4 MHz probe with the probe dia not exceeding 25 mm shall be used except when large grain size and path length make it necessary to use a lower frequency. Smaller sized probe may be used whenever necessary.

7.1.1 Testing on curved surface may be done using probes with curved shoes matching to the curvature of the job to avoid rocking, in the case of small diameter forgings.

7.2 Time Base Calibration — The time base shall be calibrated using a known dimension of the forgings, under examination, before commencement of the testing.

7.3 Sensitivity

7.3.1 The minimum sensitivity for testing shall be set such that the first signs of grain interference appear on the base line of the trace up to the maximum testing distance when the probe is in contact with the surface of the forging. Test sensitivity may also be determined by using appropriate flat bottom holes in the reference block or by means of DGS diagram considering the minimum size of the flaw to be detected and thickness of the material to be tested.

7.3.2 The standard reference sensitivity is that required to give a second bottom echo of half full screen height from the cylinder of plastic insert of reference block for calibration conforming to IS : 4904-1972* when the probe is placed on the metallized surface (reading A).

*Specification for reference blocks for calibration of ultrasonic flaw detection (first revision).

The test sensitivity shall be determined for each probe used by noting the attenuator reading at the testing sensitivity and subtracting this from reading A (reading B).

In subsequent recordings, an echo is smaller than a reference echo with which it is being compared, the difference shall be recorded as minus ' x dB'.

NOTE — The above sensitivity level adjustment is purely for scanning purposes. Once a defect is encountered, the sensitivity shall be adjusted as given in 8 to estimate the flaw size for purpose of classification.

7.3.3 It shall be ensured by verification at frequent intervals that the sensitivity setting remains constant throughout the period of the test.

8. ESTIMATION OF FLAW SIZE

8.1 Large Size Flaws — The size of large flaws may be estimated by moving the probe in all directions and plotting the mid-point of the probe when the defect echo falls by 50 percent or 6 dB. This is called the Probe Index Method.

8.2 Small Size Flaws

8.2.1 The size of the flaw may be estimated by moving the probe successively in four directions at right angles to each other and plotting the mid-point of the probe when echo height falls by 90 percent or 20 dB. When estimating flaw size, due allowance shall be made for beam spread, depth and orientation of flaw and diameter of the forging if the test is carried out on a curved surface.

8.2.2 The size of the flaw may also be estimated by comparing with the drilled holes at the appropriate depths in a test block of the same material under same heat-treatment conditions, if any.

8.2.3 When calibrated attenuator is provided with the equipment, the size of small flaws (smaller than the beam spread diameter) may also be estimated accurately in millimetres of equivalent circular flaws with the help of DGS diagram.

9. CLASSIFICATION OF FORGINGS

9.1 Forgings may be classified into following three categories depending upon magnitude of flaw indication for the purpose of ultrasonic testing. The classification is not intended to serve as an acceptance criteria for forgings, since acceptance criteria depend upon factors, such as orientation, location, nature, magnitude and size of flaws. Acceptance criterion shall

be mutually agreed upon between the manufacturer and the purchaser:

<i>Class</i>	<i>Flaw Indications</i>	<i>Recommended Method of Detect Assessment</i>
(1)	(2)	(3)
A	1) Defects giving indication larger than that from 2 mm dia equivalent artificial flaw	DGS diagram or
	2) Groups of defects with maximum indication less than that from a 2 mm dia equivalent artificial flaw but not separable at testing sensitivity if the back echo is reduced to less than 70 percent	By comparison with drilled flat bottomed hole
B	1) Defects giving indication larger than that from a 5 mm dia equivalent artificial flaw	DGS diagram or
	2) Groups of defects with maximum indication less than that from 5 mm dia equivalent artificial flaw but not separable at testing sensitivity if the back echo is reduced to less than 50 percent	By comparison with drill flat bottomed hole or Probe index method
C	1) Defects giving indication larger than that from a 10 mm dia equivalent artificial flaw	DGS diagram
	2) Groups of defects with maximum indication less than that from a 10 mm dia equivalent artificial flaw but not separable at testing sensitivity if the back echo is reduced to less than 20 percent	By comparison with drilled flat bottomed hole or Probe index method

10. TEST REPORT

10.1 The following information should be included in the report of an ultrasonic test:

- Identification, shape and size of forging.
- Date of examination.
- Material specification.
- Stage of production and heat treatment.
- Surface condition.
- Test equipment.
- Test frequency.

- h) Description of probes, and method of scanning.
- j) Couplant used.
- k) Reference standard.
- m) Attenuator (or gain control) setting:
 - 1) At reference standard.
 - 2) At testing sensitivity.
- n) Test results:
 - Type (if identifiable), size or equivalent flaw size, depth and location of defect and loss of back echo due to defects, and method of flaw size evaluation.
- p) If possible, a sketch showing the physical outline of the forging indicating the approximate location and size of the defective areas should be appended to the test results.

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